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NOMENCLATURAL CHANGES IN *CYLINDROPUNTIA* (CACTACEAE)

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ABSTRACT

The following nomenclatural novelties are established in the genus *Cylindropuntia*: *C. acanthocarpa* subsp. *ramosa* (Peebles) M.A.Baker & Cloud-H., *C. alcahes* subsp. *gigantensis* (Rebman) Rebman; *C. alcahes* subsp. *mcgillii* (Rebman) Rebman; *C. ganderi* subsp. *catavinensis* (Rebman) Rebman; *C. imbricata* subsp. *rosea* (DC.) M.A.Baker; *C. imbricata* subsp. *spinosior* (Engelmann) M.A.Baker, Cloud-H. & Majure; *C. imbricata* subsp. *spinotecta* (Griffiths) M.A.Baker; *C. thurberi* subsp. *versicolor* (Engelmann ex J.M.Coulter) M.A.Baker; *C. whipplei* subsp. *enodis* (Peebles) M.A.Baker. A lectotype is designated for the name *Opuntia whipplei* var. *enodis* Peebles.

Key Words: *Cylindropuntia*; DNA analysis; geography; lectotypification; morphology; nomenclatural changes; ploidy.

This paper proposes a number of nomenclatural changes, along with relevant synonymies, within the genus *Cylindropuntia* (Engelmann) F.M.Knuth. Many of the taxa treated here were previously placed in the genus *Opuntia* and later transferred to *Cylindropuntia* (Knuth 1930; Backeberg and Knuth 1935; Backeberg 1958; Pinkava et al. 2001). Turner and Nesom (2000) present a reasonable argument for using varieties as a primary taxonomic unit below the species level. They quote the Saint Louis Code (Greuter et al. 2000), which in Art. 4.1 lists variety as the only secondary rank between species and form and states that, if additional ranks are needed, then subspecies may be used between species and variety (Art. 4.2). However, the newest code (Turland et al. 2018) includes a note after Art. 4.2 that the rank subspecies may be used whether or not a variety rank has been adopted. A thorough presentation of the historical uses of varieties and subspecies is given by Clausen (1941), who, while not disregarding the need for the rank of variety, argues that subspecies should be used when ample empirical data are available and/or there exists a well-established geographic and/or ecological distribution that mostly differs from other subspecies. Stebbins (1950) had a similar concept, stating:

> The subspecies or geographic variety is a series of populations having certain morphological and physiological characteristics in common, inhabiting a geographic subdivision of the range of the species, or a series of similar ecological habitats, and differing in several characters from typical members of other subspecies, although connected with one or more of them by a series of intergrading forms.
>
> (p. 33)

Pederson (1998) presents a similar view to that of Clausen and Stebbins and suggests that autotetraploids should be treated as conspecific with their diploid progenitors. Although cactus taxonomists have recently used subspecies to circumscribe populations that are geographically correlated with morphology (Baker 2006; Baker and Butterworth 2013; Baker and Porter 2016; Majure et al. 2017), some authors have made subspecies designations with little or no associated empirical or geographical data.

The following new combinations are made after many years of cytological, morphological, DNA, common garden, and herbarium studies by the authors and their colleagues, which have shown that certain groups of *Cylindropuntia* populations possess a unique combination of morphology, ploidy, and distribution, but cannot be easily separated by DNA sequencing from a sister taxon or sister taxa. In addition, all of our subspecies occur within a fairly unique distribution, but morphologically intergrade with a sister taxon or sister taxa where their distributions overlap.

Nomenclature

Cylindropuntia acanthocarpa subsp. **ramosa** (Peebles) M.A.Baker & Cloud-H. stat. nov. *Opuntia acanthocarpa* Engelmann & J.M.Bigelow var. *ramosa* Peebles, Cact. Succ. J. (Los Angeles) 9:37. 1937. *Cylindropuntia acanthocarpa* var. *ramosa* (Peebles) Backeberg, Cactaceae (Backeberg) 1:181. 1958. Lectotype: USA, Arizona, Pinal County, near Sacaton, cultivated, 1920, *A. R. Leding SF* 2. (US 1699996!) The type sheet has specimens collected on more than one date and thus represents multiple gatherings: Mounted stem with single dry flower was designated as the lectotype by M Baker (Baker et al. 2018), Isolectotype: stems with flowers (ARIZ 94443!).

Populations of this subspecies occur in the eastern Sonoran Desert, as opposed to the typical subspecies, which occurs primarily in the western Sonoran and Mojave deserts. The third subspecies, *C. acanthocarpa* subsp. *thornberi* (Thornber & Bonker) Lodé occurs in the highlands of central Arizona. A statistical correlation among the geographical range and morphology of the subspecies (as varieties) was reported by Baker et al. (2018), and a DNA study of the diploid species within the genus supports these taxa as belonging to a singles species (Majure et al. *in review*).

Cylindropuntia alcahes subsp. **gigantensis** (Rebman) Rebman stat. nov. *Cylindropuntia alcahes* var. *gigantensis* Rebman, Madroño 62(1):47, fig. 1, map 2. 2015. Holotype: MEXICO, Baja California Sur, 111°58′W, 26°19′N, lava fields on the road to La Purísima, 24 May 1992, *Rebman et al. 1404*, ASU 187536!; Isotypes: BCMEX 5106, HCIB 3277; DES 00037111!.

Cylindropuntia alcahes subsp. *gigantensis* (Rebman) U.Guzmán, Cactaceae Syst. Init. 16:16. 2003, nom. inval. (based on an unpublished basionym).

Endemic to Baja California Sur, from the Sierra El Giganta, north to the Sierra El Mezquital (Rebman 2015).

Cylindropuntia alcahes subsp. **mcgillii** (Rebman) Rebman stat. nov. *Cylindropuntia alcahes* var. *mcgillii* Rebman Madroño 62(1):50, figs. 2 (map), 3. 2015. Holotype: MEXICO, Baja California, 115°47′W, 30°09′N, ca. 8 mi N of El Rosario along Rte. 1 at km marker 42, 31 May 1991, *Rebman 1219* & *Cota*, ASU 186273!; Isotypes: BCMEX 5581, SD 137583.

Cylindropuntia alcahes subsp. *mcgillii* (Rebman) U.Guzmán, Cactaceae Syst. Init. 16:16. 2003, nom. inval. (based on an unpublished basionym).

The subspecies is restricted to approximately 200 km of coastal scrub near El Rosario, Baja California (Rebman 2015).

Cylindropuntia ganderi (C.B.Wolf) Rebman & Pinkava subsp. **catavinensis** (Rebman) Rebman stat. nov. *Cylindropuntia ganderi* (C.B.Wolf) Rebman & Pinkava var. *catavinensis* Rebman**,** Madroño 62(1):55. 2015, Holotype: MEXICO, Baja California, 114°46′W, 29°47′N, Rte. 1, ca. 2 mi N of Cataviña and 3 mi S of the road to San José Faro, 23 Apr 1993, *Rebman 1723* & *Davis*, ASU 190076!, Isotypes: BCMEX 5854, SD 136474!.

Cylindropuntia ganderi subsp. *catavinensis* (Rebman) U.Guzmán, Cactaceae Syst. Init. 16:16. 2003, nom. inval. (based on an unpublished basionym)

The subspecies is restricted to about 100 km north to south, in the vicinity of Cataviña, Baja California, while the typical subspecies occurs in the northern Sierra San Pedro Mártir, Baja California to southern California, in the western Sonoran Desert (Rebman 2015).

Cylindropuntia imbricata (Haworth) F.M.Knuth subsp. **rosea** (DC.) M.A.Baker. stat. nov. *Opuntia rosea* DC. Prodr. (A.P.deCandolle) 3:471. 1828. *Cylindropuntia rosea* (DC.) Backeberg Cactaceae (Backeberg) 1:197. 1958. *Cylindropuntia imbricata* (Haworth) F.M.Knuth var. *rosea* (DC.) M.A.Baker Haseltonia 25:13. 2018. Holotype: figure of *Cactus quadrifolius* in Mociño, Fl. Mex. ined., DC. no. 406, preserved in the Hunt Institution for Botanical Documentation no. 880.

This subspecies represents the southern geographical morphotype of the species occurring in the San Luis Potosí/ Guanajuato desert grasslands and distinguished by greener stems, fewer spines, less tuberculate fruits, and smaller, paler flowers than those of the typical subspecies (Baker and Pinkava 2018).

Cylindropuntia imbricata (Haworth) F.M.Knuth subsp. **spinosior** (Engelmann) M.A.Baker, Cloud-H. & Majure stat. nov. *Opuntia whipplei* Engelmann & J.M.Bigelow var. *spinosior* Engelmann, Proc. Amer. Acad. Arts 3: 07. 1856. Opuntia spinosior (Engelmann) Toumey Bot. Gaz. 25: 119. 1898. *Cylindropuntia spinosior* (Engelmann) F.M.Knuth, Kaktus-ABC [Backeberg & Knuth] 126. 1936. *Cylindropuntia imbricata* (Haworth) F.M.Knuth var. *spinosior* M.A.Baker, Cloud-H. & Majure, Haseltonia 25:13. 2018. *Grusonia spinosior* (Engelmann) Goodwyn ex G.D.Rowley, *Tephrocactus* Study Group 12(3):45. 2006. Lectotype: Designated by L. D. Benson (Benson 1982), *Schott, no. 5*, June 1855, MO 2015359!, Isolectotype: POM 317797!.

Opuntia spinosior var. *neomexicana* Toumey, Bot. Gaz. 25:119. 1898.

This subspecies represents Sonoran Desert populations of the species and is differentiated from other

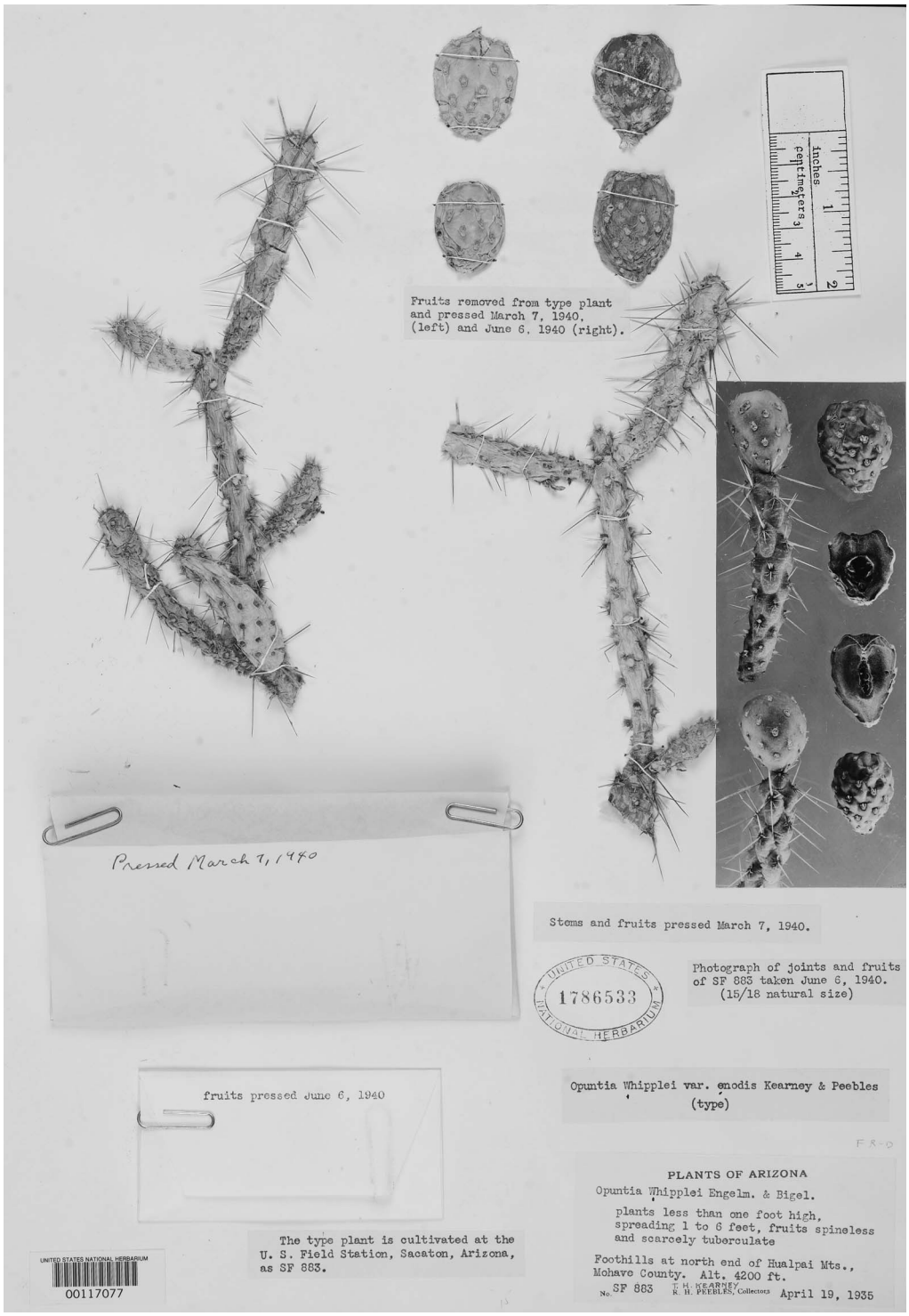

FIG. 1. Type sheet of *Opuntia whipplei* var. *enodis*, *Peebles SF 883*, US 1786533. LECTOTYPE: The two fruits in the upper right-hand corner of the sheet labeled "Fruits removed from type plant... and pressed June 6, 1940 (right)", contents of packet on the lower left-hand corner of the sheet labeled "fruits pressed June 6, 1940"; and photograph labeled "Photograph of joints and fruits of SF883 taken June 6, 1940 (15/18 natural size)".

subspecies by shorter spines and lower, more crowded tubercles. The placement of *Cylindropuntia spinosior* within *C. imbricata* resulted, in part, from recent DNA analyses (Baker and Pinkava 2018, Majure et al. *in review*)

Cylindropuntia imbricata subsp. **spinotecta** (Giffiths) M.A.Baker stat. nov. *Opuntia spinotecta* Griffiths, Proc Biol. Soc. Wash. 27:24. 1914. *Cylindropuntia imbricata* var. *spinitecta* (Giffiths) M.A.Baker Haseltonia 15:119. 2009. Holotype: MEXICO, Durango, 28 September 1909, *Griffiths 9859*, US 3053030, Isotype: POM288220!.

This subspecies represents populations of the species occurring in the highlands of Durango and Zacatecas, distinguished from the typical subspecies by fewer central spines per areole, lower and narrower stem tubercles, and the presence of at least some fusiform, tuber-like roots (Baker et al. 2009).

Cylindropuntia thurberi (Engelmann) F.M.Knuth subsp. **versicolor** (Engelmann ex J.M.Coulter) M.A.Baker comb. & stat. nov. *Opuntia versicolor* Engelmann ex J.M.Coulter, Contr. U.S. Natl. Herb. 3(7):452. 1896. *Opuntia thurberi* subsp. *versicolor* (Engelmann ex J.M.Coulter) Felger, J. Arizona Acad. Sci. 6:83. 1970. *Cylindropuntia versicolor* (Engelmann ex J.M.Coulter) F.M.Knuth Kaktus-ABC [Backeb. & Knuth] 125. 1936. Lectotype: Designated by L. D. Benson (Benson 1982), Mesas and foothills, 18 May 1881, *C. G. Pringle s. n.*, MO 2015376!, Isolectotypes: AC 00320516!; CM 284297!; F 98068!, 404515; G 00236625!, 00236570!; GH 00063179!; ISC 249224!; K 000100821!; MO 2015374!; NY 00386010!; P 4515904!; PH 01077601!; RSA 313597!; US 41045, 795896; VT 024793!.

Opuntia versicolor Engelmann ex Toumey, Gard. & Forest 8 (no. 390): 325, adnot., 326. 1895; nom. inval. (without description).

This subspecies represents populations of the species occurring in the Sonoran Desert and having thicker stems, shorter tubercles and longer, more numerous spines than the typical subspecies. Although the typical subspecies is often considered to occur primarily in the subtropical deciduous forest (Sonoran-Sinaloan transition subtropical dry forest), it also occurs in upland habitats of the Sierra Madre Occidentale (see Felger and Lowe 1970), which includes the type locality for the species

Cylindropuntia whipplei (Engelmann & J.M.Bigelow) F.M.Knuth subsp. **enodis** (Peebles) M.A.Baker stat. nov. *Opuntia whipplei* Engelmann & J.M.Bigelow var. *enodis* Peebles, J. Wash. Acad. Sci. 30:473. 1940, Cylindropuntia whipplei var. enodis (Peebles) Backeb. Cactaceae (Backeberg) 1:180. 1958. Type: USA, Arizona, Mohave Co., "North end of Hualapai Mountain, Mohave County, Ariz., altitude 4200 ft, *Peebles SF 883*, April 19, 1935," referring to a plant collected from the field on that day and then cultivated at the U. S. Field Station, Sacaton, Arizona. Apparently, no material was processed as an herbarium specimen at that time. Type Sheet: US 1786533!. The sheet, which has the word "type" in the same typewritten font as the main label, has materials collected on more than one date and thus represents multiple gatherings (see Art 8.2 Turland et al. 2018), Lectotype: Designated here by M. A. Baker as material collected June 6, 1940 on US 1786533 (Fig. 1): The two fruits in the upper right-hand corner of the sheet labelled "Fruits removed from type plant... and pressed June 6, 1940 (right)", contents of packet on the lower left-hand corner of the sheet labelled "fruits pressed June 6, 1940"; and photograph labelled "Photograph of joints and fruits of SF883 taken June 6, 1940 (15/18 natural size)". Isolectotypes: ARIZ 95988! (the word "isotype" is handwritten on the sheet), CAS 548490! (the word "isotype" is typed on the label).

Although Peebles specifies April 19, 1935 as the date of collection, this referred only to the living material that was planted at the U. S. Field Station, Sacaton, Arizona, under the living collections number SF883. The herbarium material collected June 6, 1940 was obviously seen by him before he submitted his and Wheeler's manuscript, which was received by the publisher August 6, 1940. Unfortunately, the material labelled May 7, 1940 on the US sheet, is more complete, comprising both stems and fruits. The June 6, 1940 material is selected as the lectotype because it is the same date that the materials were collected for CAS and ARIZ isolectotypes. In Peebles' protologue, he mentions only that the fruit tubercles of *O. whipplei* var. *enodis* are "broad, low, and not prominent" in comparison to the typical variety, thus the presence of fruits and a photograph of the fruits on the lectotype is sufficient to represent the taxon. Note that there was no other material mentioned in the protologue beyond SF883 and no indication that any material was collected as an herbarium specimen on the date that the live material was collected from the field.

This subspecies represents tetraploid populations of the species occurring primarily in the Mojave Desert and having a more diminutive habit, smaller stems, fewer spines, and less tuberculate fruits than the typical diploid subspecies. Morphological differences between the two subspecies are less pronounced at higher elevations where the two subspecies are sympatric (Baker 2016).

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